
Space Weather Technical Forecast

Issued on Saturday, 20 April 2024 at 01:34 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Further M-flares likely and a slight chance of X-flares. Slight chance of G1/Minor Geomagnetic Storms, mainly Days 2-4 due to possible glancing CMEs.

Solar Activity: Activity is currently Moderate, with the largest flare of M2.1 peaking at 19/0453 UTC from AR3647 in the southeast. Background irradiance remains at C-class. There are currently fifteen sunspot regions on the visible disc. There is large and complex area of active regions in the central southern disc which comprises of a number of relatively unstable and complex regions that magnetically interacting and are susceptible to significant flaring. Individually the regions are relatively modest in size, with AR3645 the largest region within the feature and one of the two largest regions on the disc, along with AR3639 in the north. The remaining numbered regions appear generally stable. A new region has emerged just ahead of the complex in the south-centre of the disc.

Several CMEs have been observed on LASCO imagery to the south and southeast, these are thought to be attributed to a number of eruptions that have originated from the vicinity of AR3638 during 19 Apr. Analysis of these CMEs is currently underway and awaiting Enlil modelling. Low confidence in the potential for any Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar wind parameters started the period at background levels, before increasing to slightly elevated levels, just above 400km/s, due to the late arrival of a CME which left the Sun on the 15 Apr and arrived at L1/DSCOVR at 19/0411 UTC. Since 19/1350UTC winds have gradually increased further and are now close to Elevated levels 490-500km/s, this is thought to be the result of an early connection to the HSS from CH25/-. Density was below average initially, before increasing to above average levels, peaking at 30ppcc at 19/0810 UTC, following the arrival of the CME. Density has declined to fluctuate between average and above average levels. The Interplanetary magnetic field (IMF) strength, Bt, was initially weak, before increasing around 19/0500 UTC to Moderate to Strong with a peak of 18nT at 19/1427UTC. Values decreased from around 19/1900UTC and have been weak since 19/2243UTC. The north-south component, Bz, weakly fluctuated initially, before significantly declining into the negative due to the CME, reaching -13nT at 19/0741 UTC and -17nT at 19/1552UTC after connection to the HSS. Bz has weakly fluctuated since 19/1830 UTC and is now weakly positive. Phi angle was mostly negative (towards the Sun) with some, mostly brief, periods of positive (away from the Sun). Resultant geomagnetic activity was Quiet (Kp0-2) initially, before increasing to reach G1/Minor Storm (Kp5) interval from 19/0600-0900 UTC and peaking at G2/Moderate Storm (Kp 6) 19/1500-1800 and 19/1800-2100UTC. Some observatories reported Kp 7 during those intervals.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES-18 was at background. High energy electron flux (greater than 2MeV) observed at GOES-16 was predominantly at background levels, occasionally reaching moderate levels. The associated 24-hour fluence remained below Active ($1e8$ integrated flux) with a value of $1.02e6$ integrated pfu observed at 20/0000 UTC.

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Four-Day Space Weather Forecast Summary

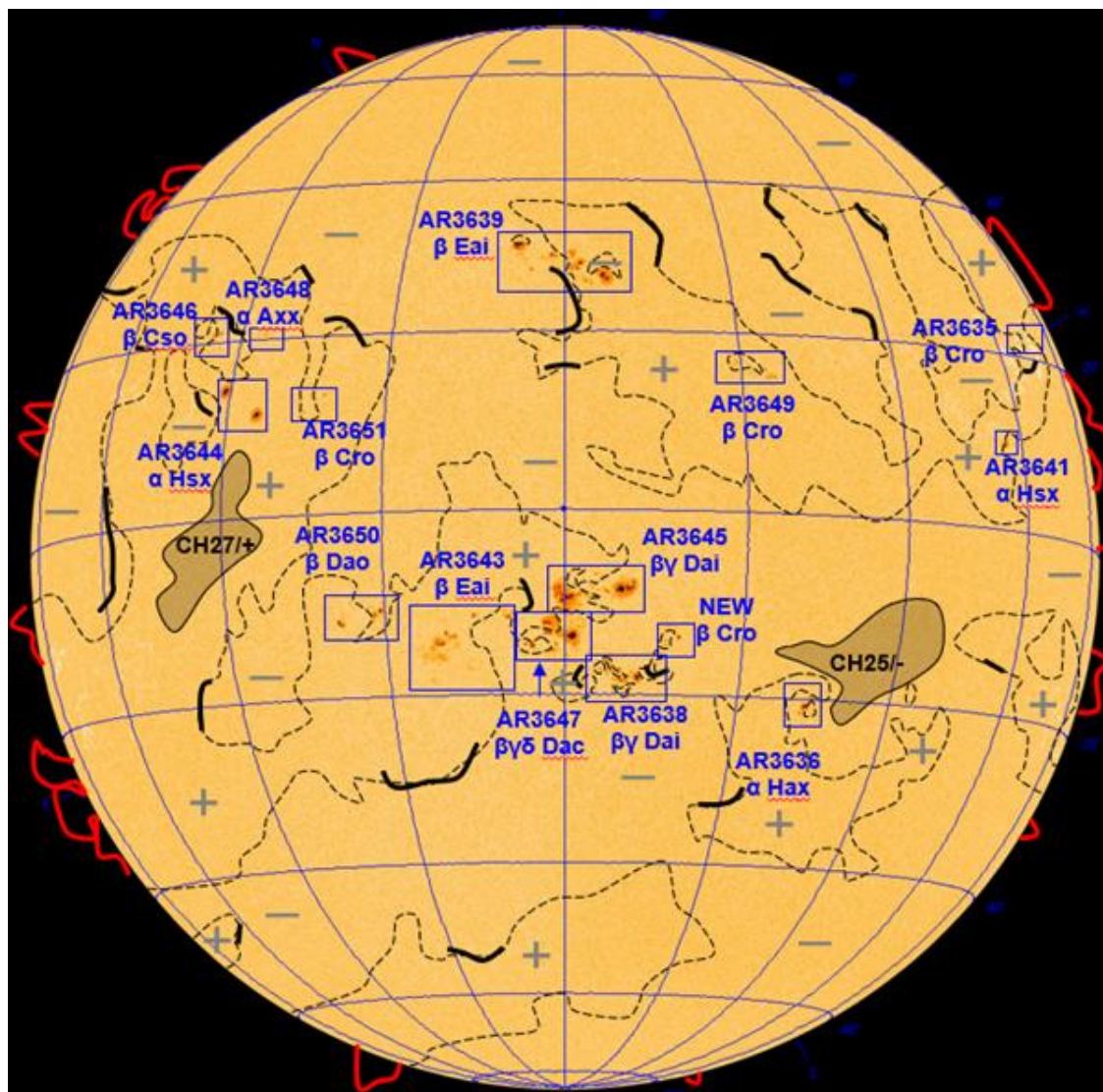
Solar Activity: Moderate activity is forecast with isolated M-class flares expected throughout and a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: Solar winds are currently at slightly elevated levels due to the combination of the recent CME arrival and the onset of a recurrent coronal hole high speed stream. This feature is expected to become increasingly geoeffective through Day 1 (20 Apr) with wind speeds likely increasing to elevated levels before waning Day 3 (22 Apr). Slight chance of further enhancement should glancing blows from CMEs occur during the period.

Geomagnetic activity is expected to decline to be mostly Quiet (Kp 1-2) or Unsettled (Kp 3) through the period. There is a slight chance that activity may increase again to Active or G1/Minor Storm (Kp 4-5) levels Day 1 but this is considered low confidence. Weak glancing blows from CMEs are possible late Day 2 (21 Apr) or Day 3 (22 Apr), with low confidence for further glancing blows Days 3-4, with associated ongoing slight chance of Active or G1/Minor Storm (Kp 4-5) intervals.

Energetic Particles / Solar Radiation: High energy proton flux as observed by GOES-18 is forecasted to persist at background. High energy electron flux as observed by GOES-16 is expected to remain at background to moderate levels with slight recovery expected later in the period. The associated 24hr electron fluence is expected to remain below the Active ($1e8$ integrated pfu) threshold but may increase in response to recent geomagnetic activity towards the end of the period.

Figure 1. Solar Analysis Valid 19/1945UTC.



Key: Filament ___, Prominence ___, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A CME that left the Sun following a flare and subsequent filament eruption, from the southeast disc near AR3636 on 15 Apr, looks to have arrived early on 19 Apr, which increased geomagnetic activity reaching G1/Minor Storm (Kp5) during the intervals within 19/0600-1500 UTC. Activity then increased to G2/Moderate Storm 19/1500-1800 UTC and 19/1800-2100UTC but has since declined to Kp 3.

The additional enhancement is likely to be the result of an early connection to Coronal hole 25 in the southeast disc which was expected to become geoeffective during Day 1 (20 Apr). This is a persistent feature and gave peak speeds of around 550km/s on the previous rotation. The coronal hole itself appears smaller than on the previous rotation, though its equivalent position on the disc remains similar, so persistence forecasting for the onset carries moderately-high confidence, though likely with lower peak speeds than seen in March. Wind speeds are expected to wane during Day 3 (22 Apr) returning towards background levels. This feature is not

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adequately modelled by Enlil. Slight chance of further enhancement should glancing blows from CMEs occur during the period.

Several CMEs have been observed from an area near AR3638 during 18 and 19 Apr. Analysis of the 18 Apr CMEs suggests the potential for weak glancing blows late Day 2 (21 Apr) or early Day 3 (22 Apr). Analysis of the 19 Apr CMEs has been completed and is in the process of being assimilated and modelled by Enlil with empirical techniques suggesting the possibility of an arrival during Day 4 (23 Apr). There is low confidence with the potential for the arrival of any of these features, which is reflected in the geomagnetic forecast.

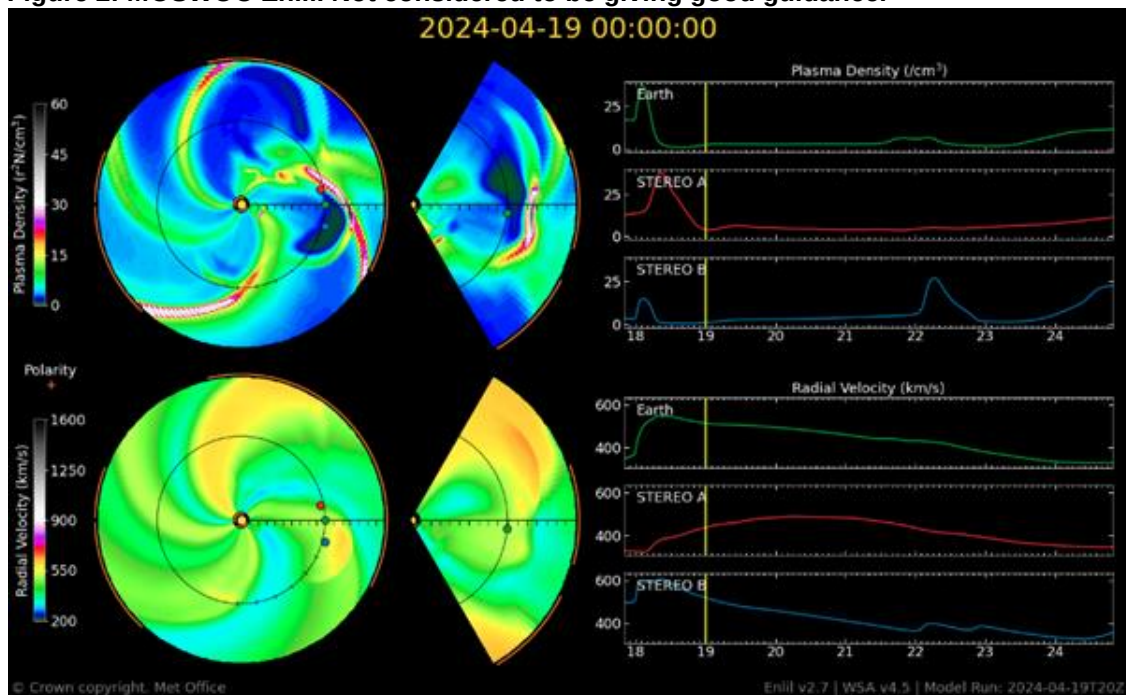
Geomagnetic activity is currently Active (Kp 4) and in the absence of further enhancement associated with the HSS from CH25/- is expected to decline to be mostly Quiet (Kp 1-2) or Unsettled (Kp 3) through Day 1 (20 Apr). There is a slight chance that activity may increase again to Active or G1/Minor Storm (Kp 4-5) levels but this is considered low confidence. The possibility of CME arrivals Days 2-4 results in an ongoing slight chance of Active or G1/Minor Storm (Kp 4-5) intervals.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	Yes	20	20	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/1142	Partial	Filament Eruption	NE	640 km/s	Arrived 19/0500 UTC	G1-G2 Observed.
18/1304	Partial	AR3638	SE-central	390 km/s	21/2100UTC +/-6hrs	Weak glancing blow.

Figure 2: MOSWOC Enlil. Not considered to be giving good guidance.



Radio Blackouts - X-Ray Flares:

There are fifteen regions on the visible disc, one of which emerged late on 19 Apr to the west of a large and complex area of active regions in the central southern disc. This complex comprises of AR3643, AR3645 and AR3647, and to a lesser extent AR3638. This is an area of interacting spots, with complex polarity mixing and an overarching magnetic structure visible in SDO imagery, and includes one clear, albeit weak, delta configuration as part of AR3647. While individually the regions are relatively modest in size, this interactivity means that this area contains the potential for notable flaring. AR3650 is also near to this group, with some interaction possible.

The other large region AR3639 in the north is magnetically simple and stable in comparison. The remaining numbered regions appear generally stable with only slight changes.

Moderate activity is expected with isolated M-class flares and a slight chance of isolated X-class flares, most likely to emanate from the complex region in the south-centre disc. These regions are currently not close expected to rotate beyond the visible disc during the period, so forecast probabilities remain constant.

Bright areas are observable on SDO imagery close to the southeast limb, and have been responsible for producing flares/CMEs during 19 Apr. These regions may rotate onto the disc late Day 1 or Day 2 (20-21 Apr) and may contribute to the flare risk when they emerge.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	10	10	10

Figure 3: X-Ray Trace past 24hours



Solar Radiation Storms - (High Energy Protons):

High energy proton flux as observed by GOES-18 has persisted at background levels and is expected to generally remain so. There is a slight chance of the observed flux increasing in response to any notable flares. This is initially due to Ex-AR3634, which continues to rotate away from the visible disc. The regions most likely to produce proton rich flares will gradually rotate west, reaching more favourable positions for proton rich flares to be observed at GEO, especially towards the end of the period.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	10	15	15
Very Active	≥ S3 *	No	1	1	1	1

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	15	15
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2 \text{ MeV}$):

High energy electron flux as observed by GOES-16 is expected to remain at background to moderate levels with recent and forecast enhanced geomagnetic activity expected to generally suppress values during the forecast period, perhaps recovering slightly during Day 4 (23 Apr). The associated 24hr electron fluence is expected to remain well below the Active (1×10^8 integrated pfu) threshold. A slight upwards trend is towards the end of the period with current REFM output accepted as good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: MOSWOC REFM considered to be giving good guidance at this stage.

